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Visualization of River Channel Evolution of the South Branch in Yangtze Estuary Supported by GIS

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Abstract

Supported by GIS, several of charts of the South Branch of Yangtze estuary from 1900 to 2001 was digitized and Digital Elevation Model (DEM) of channel was established, based on which evolution of it since 1900 was visualization. The results show that: (1) DEM is an effective means for visualization and quantitative analysis of the channel evolution. (2) From 1900 to 2001, the channel storage volume in the south branch of Yangtze river slightly increased with an average annual increment of 2.7 million m^3 at the depth of 0m; the entire river area was characterized by mild erosion, with the average annual erosion volume of 3.3 million m^3 and average annual erosion thickness of 0.37cm (including artificial dredging and reclamation as well as dredging amount). (3) The erosion and deposition state varied in different sections and at different time. Before 1958 and after 1979, the channel was characterized by erosion and expansion, while it was marked by deposition from 1958 to 1979; the erosion and deposition in the section of the entrance and exit of the channel in the south branch varied more violently than that in the middle section of the channel.

Keywords: Yangtze Estuary; South Branch; evolution; visualization.

1.Introduction

South Branch is the first-level divaricating channel of the Yangtze Estuary (as shown in Figure 1), and its evolution has always been the focus of port and channel builders [1-4]. This paper utilizes the chart of South Branch of Yangtze River estuary from 1900 to 2001 to establish the underwater DEM in each period, visualize its evolution after 1900 and conduct quantitative analysis on its evolution features, for the purpose of reflecting the temporal variation law of its evolution and providing reference for the river channel regulation as well as port construction.

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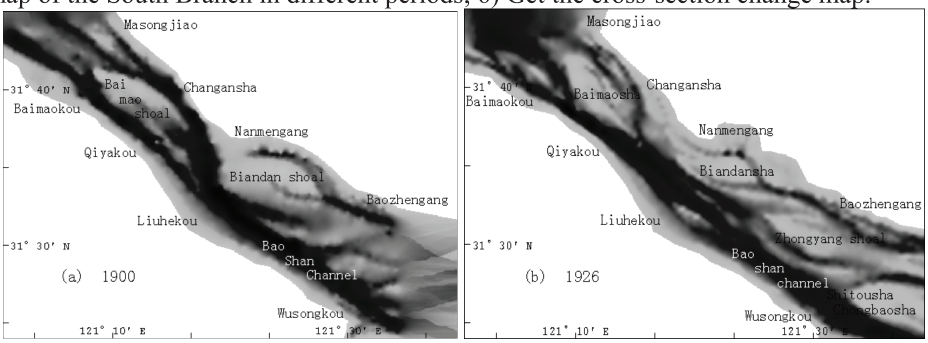
Fig.1 Sketch of the river channel of South Branch

2.The Establishment of DEM (Digital Elevation Model)

This paper utilizes charts of the channel from Wusongkou to Xuliujing respectively in 1990, 1926, 1958, 1979 and 2001 to establish the underwater DEM of South Branch River channel, shown as follows: 1) Scan each chart by sequence, use the Mapinfo to co-register each chart and convert it into the DRG (Digital Raster Graphic) with unified map projection as well as unified geographical coordinates; 2) Use Mapinfo software to digitize the collected data of the water depth in different periods and establish a database. Then change the water depth into the datum level of theoretical depth; 3) Use the Kriging interpolation method and Surfer software to conduct interpolation on the revised value of water depth and generate GRID as well as DEM; 4) on the basis of the DEM, grey-scale map of river channel's underwater topography as well as the three-dimensional topographic map are generated; 5) calculate the channel storage volume in different years and its erosion-accretion changes using Surfer to get erosion-accretion map of the South Branch in different periods; 6) Get the cross-section change map.



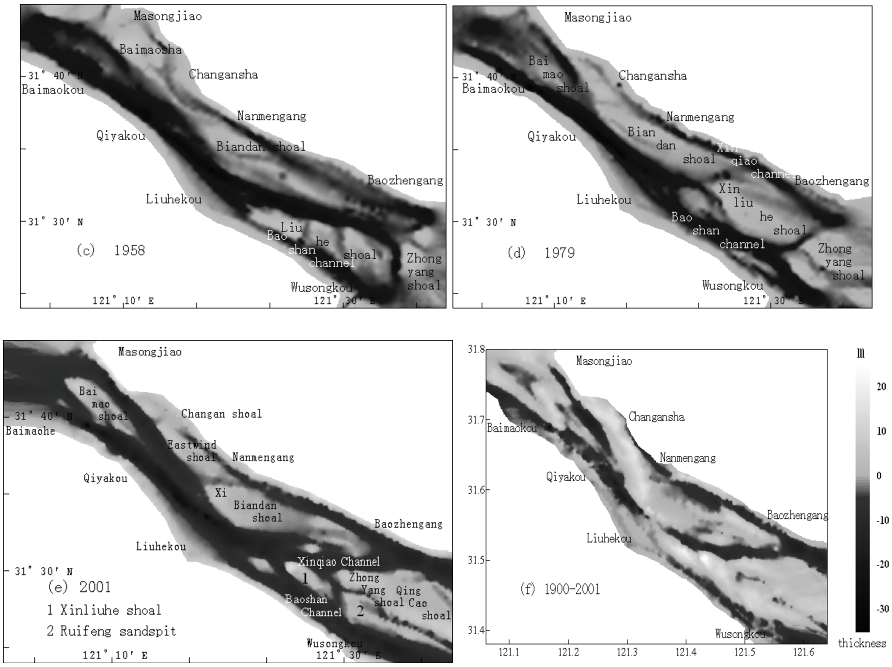


Fig.2 The relief maps(a-e) and erosion-accretion map(f) of South Branch from 1900 to 2001

3.Quantitative Analysis on the Characteristics of Channel Evolution

Changes in Channel Storage Volume of the Channel. Calculate the channel storage volume at the depth of 0m, -2m, -5m, -10m (the datum level of theoretic depth) of South Branch in various periods from 1900 to 2001 (as shown in Figure 3), and the results show that: the channel storage volume below each depth changes little with time, respectively fluctuating around 5.1 billion m^3, 3.8 billion m^3, 2.2 billion m^3 and 0.7 billion m^3; changes are different at different stages, take the channel storage volume in a depth of 0m for example, from 1900 to 1926, 1926-1958, from 1979 to 2001, the channel storage volume respectively increased 256 million m^3, 154 million m^3 and 241 million m^3 with the average annual increment of 9.8 million m^3, 4.8 million m^3 , 10.9 million m^3 (including artificial dredging and reclamation as well as dredging amount); from 1958 to 1979 the channel storage volume reduced by 380 million m^3 with the average annual decrement of 18.1 million m^3; generally speaking, from 1900 to 2001, the channel storage volume of South Branch slightly increased, and its annual increment at the depth of 0m reached 2.7 million m^3, which indicates that underwater part of the river tends to be widening.

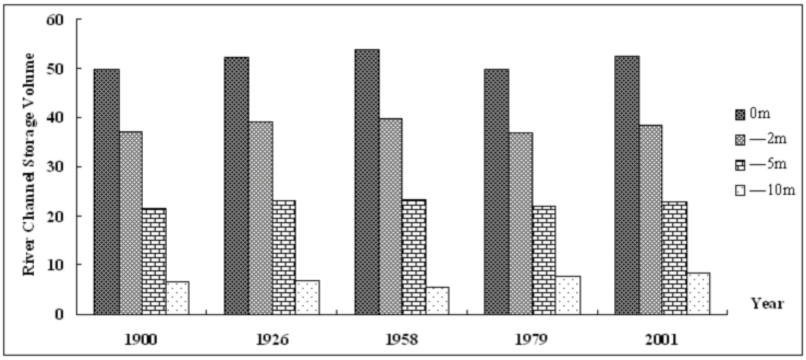


Fig.3 Change of channel storage volume of South Branch from 1900 to 2001

The Erosion and Deposition Changes of South Branch. Large number of sediment in the Yangtze River deposits in the estuary area due to the effect of combined factors such as decreasing flow rate, the impact of tide as well as the flocculating effect of saline, thus sand bodies with all shapes and sizes are formed, for some of them have emerged from the water surface (as shown in Figure 2). Calculate the erosion and deposition changes of the whole South branch including the area whose sand bodies have emerged from the water surface (as shown in Table 1), and the results show that: the erosion and deposition changing trend keeps the same with that calculated by the channel storage volume in the above chapter, that is, from 1900 to 1926, from 1926 to 1958 and from 1979 to 2001 the south branch expanded; while from 1958 to 1979 it showed as deposition. In general, from 1900 to 2001, the South Branch is characterized by mild erosion with the average annual erosion volume of 3.3 million m^3 and the average annual erosion thickness of 0.37cm (including artificial dredging and reclamation as well as dredging amount).

Table 1 Change of volume, area and thickness of deposited or eroded sediment of South Branch since from 1900 to 2001

Period	erosion and deposition volume/million m^3		erosion and deposition area/million m^2		erosion and deposition thickness/cm	
	General	Average annual	Deposition	Erosion	General	Average annual
1900-1926	-0.4	-0.015	4.73	4.39	-4.36	-0.17
1926-1958	-3.1	-0.097	4.04	4.87	-34.72	-1.81
1958-1979	1.51	0.072	4.51	4.61	16.58	0.79
1979-2001	-1.3	-0.059	3.82	5.01	-14.72	-0.67
1900-2001	-3.29	-0.033	4.36	4.32	-37.22	-0.37

Changes in Typical Cross-Sections. Select 4 cross sections (Figure 1) in different channels of South Branch River to conduct calculation, and changes in water depth of the cross section indicate that these 4 cross sections can be divided into 3 types: the first type includes 2 cross-sections, that is, Baimao River-Ma song jiao and Wusongkou – Bao Zhengang, which locate at the entrance and exit of the South Branch River. They are typical compound channels, for the sand bodies in central river channel always take changes with the swales on both sides and the width between the two channels is roughly the same with the water depth; the second type is cross-section of Qi Yakou- Chang Ansha in the upper river, which is a single channel. Its mainstream flows to the south bank, shown as the V shaped channel and with the maximum water depth gradually deepening; sand bodies in north shore are gradually connected to the

Chongming Island; the third type is the Liu River-South Gate Port cross-section in the middle and lower reach of the channel, which belongs to the atypical compound channel. Its main channel is wider and deeper than its sub channel, and the maximum depth of the main channel is increasing, while the maximum depth of sub channel is decreasing. Comparatively speaking, changes in the cross-section at the entrance and exit of South Branch River are more tremendous than that in the middle section of the channel.

Conclusion

Applying DEM technology, this paper has made a visual representation of the channel evolution in the south branch of Yangtze river estuary since 1900, and conduct quantitative calculation of changes in its erosion and deposition, which indicates that DEM is an effective mean to perform visual and quantitative analysis of the channel evolution.

From 1900 to 2001, the channel storage volume in the south branch of Yangtze river slightly increased, which increased by an average annual 2.7 million m^3 at the depth of 0m; the entire channel in south branch was characterized by mild erosion, with the average annual erosion volume of 3.3 million m^3 and average annual erosion thickness of 0.37cm (including artificial dredging and reclamation as well as dredging amount).

The erosion and deposition state vary in different sections and at different time. Before 1958 and after 1979, the channel was characterized by erosion and expansion, while it was marked by deposition from 1958 to 1979; the erosion and deposition in the section of the entrance and exit of the channel in the south branch vary more violently than that in the middle section of the channel.

References

[1] LI Zhi-lin, ZhU Qing. Digital Elevation Model (DEM) [M]. Wuhan: Wuhan University Press, 2003.

[2] LI Mao-tian, CHEN Zhong-yuan. Analysis of Jiujiang reach of the Yangtze River evolution in recent forty years using the DEM[J]. Advances In Water Science, 2004, 15 (3): 330-335.

[3] ZHANG Xia-lin, WENG Zheng-ping, TIAN Yi-ping. River Channel Storage Volume Calculation on DEM and Data Visualization[J]. Journal of Yangtze River Scientific Research Institute, 2006, 23 (2) :13-16.

[4] HU Hong-bing, CHENG He-qin, HU Fang-xi, et al. Evolution characteristics of the shoals of the second and third generation alluvial islands in the Changjiang Estuary[J]. Journal of Sediment Research, 2004 (6) :57-63